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When school science has this outlook it will lie closer to the human heart than it does at present, and a common bond of sympathy will be formed between all who are guiding the growth of young minds for both beauty and strength. So will the community of educational aims be established and the place of science in modern life be understood by a generation which will be entrusted with the task of making a new heaven and a new earth. If these trustees for the future learn to know science in spirit as well as in truth we may look forward with happy confidence to the social structure they will build, in which knowledge will be the bedrock of springs of action and wisdom will make man the worthy monarch of the world.

RICHARD GREGORY

FROG AND TOAD TADPOLES AS SOURCES OF INTESTINAL PRO- TOZOA FOR TEACHING PURPOSES

MANY teachers of protozoology and invertebrate zoology use frogs for the purpose of obtaining intestinal protozoa for class use, but it does not seem to be generally known that the tadpoles of frogs and toads are even more valuable than the adults as sources of material. Unfortunately tadpoles are most abundant late in the spring and in early summer when classes are usually not in session, but two species of frogs that are more or less common throughout the United States pass two or more seasons in the tadpole stage and hence are available in the autumn and, in the southern part of the country, at any time of the year; these are the green frog, *Rana clamitans*, and the bullfrog, *R. catesbeiana*. The former is common throughout eastern North America, inhabiting swamps and large and small ponds; the latter has a similar distribution but is limited to swamps and the larger and deeper ponds. Tadpoles should be looked for in these habitats. The identification of these, so far as their use as material for intestinal protozoa is concerned, is of little importance, but it may be stated here that the tadpoles of the two species are very similar and difficult to distinguish from each other. Full descriptions of them are given by

Wright (1914). A breeding place once found will serve as a source of supply year after year. Sample tadpoles should be collected some time before the class meets so as to determine the incidence of infection and numbers present of the various species of protozoa, since this varies from year to year. The specimens for class use may be collected several days before they are needed but should not be kept in the laboratory for more than a week or two since they tend to lose their infections under laboratory conditions. The writer has found dishes about ten inches in diameter and three inches deep containing a quart of tap water to be suitable for about twenty tadpoles each. The dishes should not be covered with glass plates, but the water should be changed every day or two. Tadpoles may be killed very quickly, as adult frogs usually are, by destroying the brain and spinal cord with a heavy needle. The ventral body wall can then be opened from the anterior to the posterior end. The intestine is coiled within the body cavity, being several hundred millimeters in length. The rectum, or posterior portion of the alimentary tract, is tightly coiled and is separated from the intestine by a constriction. The different species of intestinal protozoa are rather definitely distributed within the intestine and rectum. The anterior portion of the intestine is inhabited by a flagellate, *Giardia agilis*; in various parts of the intestine and rectum *Endameba ranarum* may be found; the rectum is the principal habitat of two genera of ciliates, *Opalina* and *Nyctotherus*, of two genera of flagellates, *Trichomonas* and *Hexamitus*, and of several green flagellates resembling members of the genera *Euglena* and *Phacus*. To study any of these species in the living condition, the part of the digestive tract containing them should be teased out in a drop of 0.7 per cent. salt solution and covered with a cover glass. Any of the species mentioned can be found with low magnification, such as obtained with a 16 mm. objective and a number 5 ocular. To study the details of most of these protozoa, however, the Schaudinn iron-haematoxylin method is necessary. This in brief is as follows: Spread the intestinal or rectal contents in a thin layer over about one half the area of

a 3x1 glass slide. Before this has a chance to dry drop it face downward into a dish containing Schaudinn's fixing solution. This is made up of a saturated solution of mercuric chloride in distilled water, 200 c.c.; 95 per cent. alcohol, 100 c.c.; and glacial acetic acid, 15 c.c. Leave in this solution for about ten minutes. The slide should then be treated by the well-known iron-hæmotoxylin method (70 per cent. alcohol plus iodine, 30 minutes to 24 hours; water, a few minutes; four per cent. aqueous solution of iron alum, 1 to 4 hours; rinse in water; 0.5 per cent. aqueous solution of hæmotoxylin, 4 to 24 hours; rinse in water; differentiate in two per cent. iron alum; wash thoroughly; dehydrate; mount).

Giardia agilis inhabits the anterior portion of the intestine. First observed by Kunstler in 1882, it has recently been studied in detail (Hegner, 1922). When alive it looks like a minute, slender tadpole and undergoes extremely rapid wriggling movements which no doubt suggested its specific name. When fixed and stained as suggested above it exhibits bilateral symmetry, with two nuclei, four pairs of flagella with intracytoplasmic portions, a pair of axostyles, and one or several parabasal bodies. Another species of this genus, *Giardia lamblia*, occurs in about 12 per cent. of human beings (Hegner and Payne, 1921). This species, which has been carefully studied and described by Simon (1921, 1922), is considered by some to be responsible for serious intestinal disturbances, but may be present in apparently healthy persons.

Trichomonas augusta is confined principally to the rectum, although it occurs occasionally in the intestine of the tadpole. This flagellate may be recognized by its jerky movement. When the living animal is examined with high magnification its active undulating membrane, along the outer edge of which is fastened a flagellum, can be seen; waves of motion start at the anterior end and pass posteriorly to the end of the body. Such an undulating membrane is characteristic of certain parasitic protozoa. The pointed extension of the rod-like axostyle may also be seen protruding from the posterior end. When fixed and stained a single nucleus, three anterior flagella, the undulating

membrane, axostyle and mouth are clearly revealed. A species of *Trichomonas*, *T. hominis*, that occurs in man is similar in appearance to that in the tadpole but does not stain well and hence its structure is difficult to determine. Trichomonads that have been recorded from man are *T. hominis*, in the intestine; *T. vaginalis*, in the vagina; and *T. buccalis*, in the mouth. The intestinal form has been found in about three per cent. of the human beings examined.

Hexamitus intestinalis is a very minute species with two nuclei, and four anterior and two posterior flagella. It is an active swimmer and moves rapidly across the microscopic field. It differs from *Trichomonas* in the absence of a mouth and probably takes in its food through the surface of the body. No species of this genus are known from man.

Nyctotherus cordiformis is a very large ciliate that is often found in the rectum of tadpoles. It appears to be a scavenger and resembles *Paramecium* in structure and in its primary life processes. A species of this genus, *N. faba*, has been recorded from man.

Opalina ranarum is also a large ciliate that is a frequent inhabitant of the rectum of tadpoles. This and other species of *Opalina* that also may be encountered in this habitat are especially interesting because of their polynuclear condition and absence of an oral aperture, food being absorbed through the body wall. The variations in nuclear number and structure in various members of the Opalinidæ are of particular interest (Metcalf, 1914). The value of these protozoa with respect to problems of geographical distribution has been emphasized by Metcalf (in press).

Balantidium entozoon is an inhabitant of the rectum of certain frogs. It has not been found by the writer in tadpoles, but probably occurs in them in certain localities. Its mouth is situated near the anterior end instead of forming a large conspicuous crescent near the center of the body as in *Nyctotherus*. A human species of *Balantidium*, *B. coli*, although not very common, is sometimes very pathogenic, causing intestinal ulcers and frequently bringing about the death of the host.

Endamæba ranarum is a species that is often abundant in tadpoles. It is of particular in-

terest because of its close resemblance to *E. histolytica*, which causes dysentery in man, and has been found in about nine per cent. of all human beings examined.

Recently the writer has discovered *Euglena*-like flagellates in the rectum and intestine of tadpoles. One species has many of the characteristics of free living *Euglenæ* including green chromatophores, a reservoir and a red stigma. This species possesses three flagella. Another species resembles *Euglena spirogyra* and a third species is similar to *Phacus pleuronectes*.

The following references contain detailed information concerning some of the organisms mentioned above:

Tadpoles. Wright, A. H., 1914. Pub. 197, Carnegie Inst. of Wash., pp. 1-98.

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Intestinal protozoa of man. Dobell, C., and O'Connor, F. W., 1921. Pp. 1-211.

Intestinal protozoa of man. Hegner, R. W., and Payne, G. C., 1921. *Scientific Monthly*, pp. 47-52.

Intestinal protozoa of man. Hegner, R. W., and Cort, W. W., 1921. Pp. 1-72.

Giardia agilis. Hegner, R. W. *Amer. Journ. Hygiene*, 2: 435-441.

Giardia lamblia. Simon, C. E. *Amer. Journ. Hygiene*, 2: 406-434.

Trichomonas augusta. Kofoid, C. A., and Swezy, O., 1915. *Proc. Amer. Acad. Arts and Sci.*, 51: 289-378.

Nyctotherus cordiformis. Bezzenger, O. 1904. *Arch. f. Protist.*, 3: 138-174.

Opalina ranarum. Metcalf, M. M., 1909. *Arch. f. Protist.*, 13: 195-375.

Opalina ranarum. Metcalf, M. M., 1914. *Zool. Aus.*, 44: 533-541.

Balantidium entozoon. Bezzenger, O., 1904. *Arch. f. Protist.*, 3: 138-174.

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SCIENTIFIC EVENTS

ALEXANDER SMITH

THE New York Section of the American Chemical Society having appointed a committee, consisting of Professors Thomas B. Freas, Ralph H. McKee and James Kendall, chairman, to draw up resolutions in memory

of the late Professor Smith, the following resolutions were prepared and approved by the section on October 6:

Whereas, By the death of Alexander Smith at Edinburgh on September 8, 1922, the American Chemical Society has been deprived of a past president and the New York Section has lost one of its most highly esteemed members:

And whereas, Although the work of Alexander Smith as a teacher, as an administrator, and as an investigator in chemistry survives as an enduring monument to his name, yet it is none the less our privilege to put on record in the minutes of the section our sincere appreciation of his outstanding scientific genius and of his rare personal integrity and charm;

Be it therefore resolved, That the New York Section of the American Chemical Society express its profound regret at the passing of this distinguished leader in chemistry, who by his labors has added luster to science both in the land of his birth and in the land of his adoption;

And be it further resolved, That copies of this memorandum be forwarded to his widow and to his sister, with the respectful sympathy of the section.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 21

DR. A. C. D. CROMMELIN, writing in *Nature*, says that the failure of the Christmas Island eclipse expedition is a great astronomical disappointment. Messrs. Jones and Melotte have devoted ten months or more to it, and hoped to secure useful photometric results for connecting the northern and southern stellar magnitude scales in addition to the eclipse work. The climate, however, proved unexpectedly unfavorable, and practically nothing could be done.

On the other hand, the conditions appear to have been ideal right across Australia, and enthusiastic reports have come from Wollal (West Coast), Cordillo Downs (center) and Goondiwindi and Stanthorpe (Queensland). The Einstein problem was studied at Wollal by the Lick Observatory party under Professor Campbell, and that from Toronto under Professor Chant. Mr. Evershed also finally selected this station in preference to the Maldives, and is believed to have undertaken the same investigation, in addition, doubtless, to spectroscopic work. Professor Dodwell, the government as-